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Format for submission of Ph. D. Synopsois / Work plan

For faculty of Science to be submitted in front of RRC

TITLE OF PROPOSED WORK : "Heterosis and Combining Ability Studies in Mungbean (*vigna radiate (*L.*)* Wilczek)"

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1. Introduction

Mungbean (*vigna radiate (*L.*)* Wilczek) is a self pollinated legume originated in south Asia. The word legume is derived from the word 'large ' which means 'to gather' or picked by hands, as distinct form reaping the cereal crops. It is an economically important crop in India, Pakistatn , Thialand, Vieatnam, Myanmor and China.

Mungbean also known as green gram, it is short duration grain legume with wider adoptability. Mungbean is considered to be originated from *Vigna Sablobata.* The origin of mungbean is supposed to be India (Vavilov, 1926 and Zukoveshij 1962). In India it is one of the most important crop grown on large area. In Maharashtra it ranks second in *kharif* crop grown after Pigeonpea with area 4.30 lakh hector (ha) with production of 2.07 lakh tannes with productivity 483 kg/ha (Chief stastician Commisionarate of Agriculture Report 2013-14, Pune). It is mainly used in making Dal, snacks, curries and soup. The germinated seeds have more nutritional value compared with Asporagus or Mushroom. The food value of mungbean lie in it's high and easily digestible protein. The mungbean seeds contain approximately 25-28 % protein on dry weight basis.

Mung bean is important source of dietary protein in all over the world but in major in Asia, Africa and Latin America. The protein content and amino acids of the protein and its digestibility determines the food value of mungbean (Casey and Wriniey 1982). It is used in multiple cropping systems with cereals, groundnut, sugarcane and other crops, following an important component of crop rotation.

Botany

Mung bean belongs to family *leguminaceae* and sub family *papilionaceae*. It's chromosome number is 2n= 22. It is rapidly growing erect or sub erect, annual crop generally 30 to 90 cm in height and shown considerable variability in form and adaptation. Mungbean plant are branched and only some varieties are having spreading habit. The tips of the branches are vining. The stems are usually green but same times found splashed with purple. The branches emerge out from the base and are angular. The leaves are trifoliate with large ovate, entirely or rarely lobed, membranous leaflets 5 to 10 cm. large with scattered hairs on both sides and light to dark green in colour.

Combining ability studies utilizing line x tester analysis provides information in this direction particularly for initial screening of large number of genotype for combining ability. Study of general combining ability (gca) effects helps in selection of superior parents and specific combining ability (sca) effects for superior hybrids. The information generated in the process can be used to understand the magnitude of heterosis.

2. Review of Literature and Development in the subject (Previous work done in the relevant area):

2.1 Combining ability

Combining ability analysis provides information regarding the selection of parents in terms of the performance to their hybrids. It also gives information about nature and magnitude of various types of gene actions involved in expression of various quantitative traits. Thus the concept of combining ability is very important in plant breeding as well as animal breeding.

The concept of combining ability was first described by Sprague and Tatum (1942) in terms of genetic variation, using single cross in maize. They defined general combining ability as "the average performance of lines (inbred) in hybrid combinations", and specific combining ability as "deviation of certain crosses from expectations on the basis of average performance of the lines involved"

Griffing (1956) defined combining ability as "the relative ability of a genetype to transmit the desirable performance to its crosses".

Kempthorne (1957) defined the general and specific combining ability variances i.e. 'gca' and ‘sca’ respectively in terms of covariance of half sibs and full sibs in a random mating population.

According to Allard (1960) the general combining ability is the average performance of a strain in a series of crosses and specific combining ability as the deviation from the performance predicted on the basis of general combining ability.

Panse (1957) stated that mendelian method is not applicable to this study as the genotype for quantitative characters is directly measurable and its expression is modified by environment.

Ahuja (1980) reported that analysis of variance indicated highly significant differences among progenies for all the traits except for number of branches per plant, number of clusters per plant, seeds per pod and total dry matter in mungbean. The gca variances were significant for all traits, sca variances were significant for plant height, pods per plant and seed yield per plant.

Deshmukh and Manjare (1980) reported that the variances due to gca and sca were highly significant for almost all characters except number of grains per pod in mungbean.

Lal *et. al.,* (1982) reported the high sca effects in K 851 for grain yield and its components, while PS 16 for earliness and H 10 for bold seeds. The cross ML 1 x K 851 showed high sca effects for three characters in mungbean.

Reddy and Sreeramulu (1982) reported higher gca variance than sca variance for all the traits except plant height, where sca variance was higher which indicate the predominance of additive gene action in mungbean.

Choudhary (1986) reported highly significant gca variances for plant height, branches per plant, pods per plant and seed yield per plant while sca variances were significant for plant height and seed yield per plant in mungbean.

Halakude (1992) from 8 x 8 half diallel programme of mungbean genotypes reported that the variance due to gca were highly significant for all characters under study except protein content while sca variance were significant for all characters except the number of grains per pod.

Naidu *et. al.*,(1992) reported additive gene action for days to maturity, plant height, cluster per plant, pod length, seed yield while non-additive gene action for days to 50 per cent flowering, branches per plant and shoot dry weight at harvest in mungbean.

Naidu and Satyanarayan (1993) observed predominance gene action for days for 50 per cent flowering, days to maturity, pods per plant and seed protein where as non additive gene action for plant height, seed weight, shoot dry matter and seed yield in mungbean.

Jahagirdar (2001) reported that the estimates of the gca was more than the sca variance for days to 50% flowering and days to maturity indicating the predominance of additive gene action for these traits. Variance due to sca were higher than gca for plant height, 100 seed weight and seed yield, suggesting the predominance of non-additive gene action for these traits. Both additive and non-additive gene actions were important for branches per plant, clusters per plant and seeds per pod in mungbean.

Manivannan (2002) reported that the gene action involved in controlling characters *viz,* plant height, number of branches per plant, number of clusters per plant, number of pods per plant and seed yield per plant was non-additive gene action in mungbean. The parent KM 2163 showed good general combining ability.

Rout *et. al.,* (2009) studied combining ability analysis for nine quantitative characters through a six parent half diallel cross in mungbean to identify certain crosses that can be used in mungbean improvement programme. The analysis of the data obtain on five randomly chosen plant revealed high GCA rank for grain yield is related to the GCA for other yield components in mungbean.

Patil *et. al*., (2011) employed diallel technique in which eight genotypically diverse lines of mungbean were crossed themselves in all possible combinations excluding reciprocals. The good general combiners for seed yield per plant were GM 4, Pusa Vishal, GM 2K3, and K851. The cross combinations Pusa Vishal x SML 668, GM 4 x GM 3, GM 2K5 x GM 2K3, SML 668 x GM 4, K 851 x GM 4, GM 2K5 x K 851, GM 05 08 x K 851 and GM 2K3 x GM 4 showed the highest SCA effect for seed yield per plant.

Anbu Selvam (2012) studied the combining ability in 6 x 6 diallel set of greengram for seed yield and its components. The study revealed that the variances due to gca and sca were significant for all characters. The genotypes AUGG 1, CDML 1, and CDML 2 were found to be a good general combiners while four hybrids *viz.* CDML 2 x CDML 1, CDML 2 x AUGG 1,

CDML 1 x CDML 2, AUGG 1 x CDML 2 were identified as best specific combiners for seed yield and other productive traits.

2.2 Heterosis

The heterosis or hybrid vigour may be defined as, “The interpretation of increased vigour, size, fruitfulness, speed of development, resistance to pest and disease or to climatic rigours of any kind manifested by cross breed organisms as compared with corresponding inbreed as the specific rules of unlikeness in the constitution of the uniting parental gametes." Heterosis is mainly manifested in quantitative characters and is expressed in vigour of vegetative organs, in increased grain yield etc.

Kolreuter (1866) was the first to recognise the manifasted superiority of certain first generation hybrids in size, yield and vegetative vigour.

Darwin *(*1876) was the first to note that it was only the crossing between unrelated varieties of a plant that produce hybrid vigour.

Shull (1914) the term heterosis was first coined by Shull for the hybrid vigour.

Stebbins (1959) has defined heterosis as, "Greater adaptedness to human needs which has been obtained in a particular environment through artificial selection followed by hybridization".

Bhatnagar and Singh (1966) recorded heterosis for the first time in inter-specific crosses of green gram.

Singh (1971) suggested that the only possibility at present would be to make use of heterosis in pulse crops developing high yielding pure lines.

Rai (1979) refers the term heterosis to the phenomenon in which F_1 population obtained by the crossing of two genetically dissimilar gametes or individuals, show increased or decreased vigour over the better parents or mid parental values.

Halakude (1992) recorded negative heterosis over better parent and mid parent for days to 50 per cent flowering and days to maturity, while positive heterosis of the F_1s over better

parent and mid parent for plant height, number of clusters per plant, number of pods per cluster, 100 seed weight and yield per plant in mungbean.

Patil (1992) recorded the negative heterosis over the mid parent and better parent for days to 50 per cent flowering and days to maturity, while positive heterosis over mid parent and better parent was observed for plant height, number of clusters per plant, number of pods per cluster, 100 seed weight and yield per plant in mungbean.

Kelkar (1993) observed the positive heterosis over mid parent and better parent for plant height, number of clusters per plant, number of pods per plant and 100 seed weight, while negative heterosis was noticed for days to maturity in mungbean.

Sonawane (1995) reported the heterosis over the mid parent and better parent ranging from -7.41 to 2.39 and -10.71 to 0.00 per cent for days to 50 per cent flowering and -6.67 to -0.80 per cent and -9.29 to 1.52 per cent for days to maturity. Positive heterosis was observed for plant height, number of clusters per plant, number of pods per cluster, number of pods per plant, 100 seed weight and yield per plant in mungbean.

Reddy (1998) reported heterosis ranging from -16.00 to -1.41 per cent and -13.34 to 11.35 per cent over mid parent and better parent for days to 50 per cent flowering, and -16.0 to 1.41 per cent and -13.34 to 11.35 per cent over mid parent and better parent for days to maturity, while positive heterosis was observed for plant height, number of clusters per plant, number of pods per cluster, number of seeds per pod, pod length, 100 seed weight and yield per plant in mungbean.

Lakshmi V. *et al*., (2003) studied 29 different hybrids of mungbean resulting from 8 x 8 diallel, excluding reciprocals indicated pronounced hybrid vigour for yield and most of the yield components. Heterosis to the extent of 110.77 and 77.54% over the mid parent and better parent, respectively was recorded for grain yield per plant. Eight hybrids were identified as promising for many desirable traits and they may be of much use in exploiting hybrid vigour in mungbean.

Patel *et. al*., (2009) studied a diallel analysis in mungbean carried out from a set of 36 genotypes comprising of 8 parents and 28 F_1 crosses and reported that the highest heterobeltiosis of 62.50 per cent was recorded by cross PDM 87 x K851. The cross PDM 143 x GM 3 registered

the highest standard heterosis (36.90%) for seed yield followed by PDM 11 x GM 4 (30.95). These crosses also showed significant standard heterosis for the component trait like pods per plant and days to 50 % flowering.

Sujatha *et al.,* (2011) crossed two female lines and ten testers in a line × tester fashion to generate 20 hybrids for assessment of heterosis. Moderate to high heterosis was observed for seed yield and its 11 component traits and the maximum heterobeltiosis for early maturity was recorded in 'Chinamung' × 'Meha' and the highest better parent heterosis for seed yield/plot was reflected by the cross 'Chinamung' × 'VC 1' (136.4%) followed by 'Chinamung' × 'BPMR 1' (77.42%).

Isha parveen *et. al*., (2013) studied the magnitude of heterosis and heterobeltiosis in blackgram. The highest heterosis to the extent of 116.81% over mid parent and 101.63% over better parent for number of pods per plant was observed in the cross LBG 20 X PBG 107, which exhibited high heterosis (%) and *per se* performance for either one or more yield components.

Srivastava *et. al.,*(2013) studied twenty eight crosses of mungbean from 8 x 8 diallel excluding reciprocal to know the magnitude of heterosis over better parent and standard variety for yield and its components in mungbean. The highest heterosis to the extent of 80.76% over standard variety and 72.39% over better parent for seed yield per plant was observed in the cross Narendra Mung 1 x PS 16 which exhibited high heterosis percentage for yield and yield components.

3. Objectives of Research / Proposed Hypothesis :

1) To estimate the general combining ability (GCA) effects of parents.
2) To estimate the specific combining ability (SCA) of crosses for yield and its components.
3) To study the extent of heterosis in respect of seed yield and its components.
4) Through the combining ability analysis, breeder can identify the good combiners to exploit the heterosis or to combine the desirable fixable genes. Thus the concept of combining ability is of immense importance in plant breeding and crop improvement.
5) The development of plant breeding is based on the genetic information on the inheritance and behaviour of important quantitative characters associated with yield, quality or other economic traits. To get such genetic information to the plant breeder,

it is necessary to conceive of a genetic model in relation to the material that is proposed to be used.

6) This process involves designing a suitable mating system to fit into the chosen genetic model. There are different mating systems *viz.,* top cross, poly cross, L x T analysis and diallel analysis.

4. Methodology to be adopted :

4.1 : Experimental material

The parent for experiment included six genotypes of mungbean *(Vigna radiata* L. Wilczek) as males (Tester) BPMR 182, BPMR 132, BPMR 21, BPMR 126, BPMR 75 and BPMR 38. Four varieties as females are BM 2002-1, BM 4, JL 781 and AKM 4 . Each female was crossed with six selected male genotypes. The testers (males) chosen for study along with their characteristic features.

The experiment consists of twenty four F_1s and ten parents.

The detail of experiment is given below:

1. Mating design	: Line x tester
2. Experimental design	: Randomized block design (RBD)
3. Number of Replication	: Two
4. No. of entries/replication	: Thirty five
5. Plot size	: Single row of three meter length
6. Spacing with in row	: 10 cm
7. Spacing between the rows	: 45 cm
8. Fertilizer dose	: 25:50:0 NPK (kg/ha)
9. check/ control	: BM 2003-2

4.2 : Testing of parents and hybrids

4.3 : Collection of experimental data for following quantative characters:

Days to 50% flowering, Days to maturity, Plant height (cm), Number of clusters per plant, Number of pods per cluster, Number of pods per plants, Number of seeds per pod, Pod length (cm), 100 seed weight (g), Seed yield per plant (g), Protein (%)

4.4 : Statistical analysis

4.4.1 : Analysis of variance for parents and hybrids

The mean values of each entry and each replication for the characters recorded for the hybrids and parents were subjected to statistical analysis and variance due to different sources was worked out according to Panse and Sukhatme (1967)

4.4.2 : Estimation of heterosis

Per cent heterosis of the F_1s over the mid parent (MP) and better parent (BP) was calculated as per the method proposed by Turner (1953) and Hayes *et. al.,* (1955).

4.4.3 : Combining ability analysis

Mean data of each replication for the ten characters recorded for the hybrids were subjected to line x tester analysis. Fresh mean sum of squares along with the variance of general combining ability (gca) of the parent and specific combining ability (sca) of the hybrids were worked out based on the procedure developed by Kempthorne (1957).

4.4.4 : Estimation of combining ability effects

4.4.5 : Estimation of standard errors

4.5 : Estimation of Protein : it will be estimated by kmicrojeldhlide method.

5. Importance of study:

Status of mungbean

Green gram is an important pulses crop in India and believed to be originated from India. It is short duration legume crop grown mostly as a fallow crop in rotation with rice. Similar to the leguminous pulses, green gram, enriches soil nitrogen content. It is grown mostly in Asian region traditionally while its cultivation has spread to Africa and Americas relatively in the recent times. More than 70%t of world's green gram production comes from India.

Green gram is scientifically known as *Vigna radiata* and it is commonly known as *Mung* in India. The plant grows as a small shrub with twining upper branches.

Economic Importance:

Mung, similar to other pulses, is grown primarily for its protein rich seeds. Mung contains 20-25% protein. The plants are sometimes cut and ploughed into the soil to enrich soil nitrogen.

Domestic Scenario

India is the world's largest producer as well as consumer of green gram. It produces about 1.5 to 2.0 million tons of Mung annually from about 3 to 4 million hectares of area, with an average productivity of 500kg per hectare. Green gram output accounts for about 10-12% of total pulse production in the country.

Mung production in the country remained stable more than a decade through the 2000s at around 10 to 15 lakh tons. But a sudden jump in output was noted in 2010-11 to 17.5 lakh tonnes primarily on account of rise in production from Madhya Pradesh, Rajasthan and Tamil Nadu.

Mung production in the country is largely concentrated in five states viz, Rajasthan, Maharashtra, Andhra Pradesh, Gujarat and Bihar. These five states together contribute for about 70% of total Mung production in the country.

There is a distinct change in production pattern of Mung across states. Traditionally Rajasthan, Maharashtra, Andhra Pradesh are major Mung producing states. But there is significant rise in production from other states in recent years particularly, from Tamil Nadu, Uttar Pradesh and Gujarat. Nevertheless, production remained volatile across the years with respect to most of the states.

As per the latest available estimates, Rajasthan, Maharashtra occupies the first two positions, contributing over 45%. Andhra Pradesh contributes about 10% while together Gujarat and Bihar account for about 13% of total production in the country. (*Source: Ministry of Agriculture, GoI, IGPA and Trade Sources*)

Significance of the study

My proposed research work is more significant because mungbean is self pollinated pulse crop have a very limited genetic variability. Low genetic variability for major characters become limiting factor for its improvement. The possibility of improving yield and yield releated traits through genetic manipulation. The detail study was planned to obtained information on yield

and yield attributing traits by involving diverse parental lines through which there is chance for selection of good parent which may be utilized in breeding programme and development of variety by following further generation which may useful for farmers of the region or country.

6. Proposed work plan/ Formulation and structure of study:

Year wise plan of work and targets to be achieved.

First Year :

1) Literature survey of proposed work plan.
2) Selection of genotype to be used as parents (male and female) in crossing progrmme.
3) Making of crosses in line x tester design.
4) Separate harvesting of corsses (hybrids).

Second Year:

1) Sowing of hybrids in single line with parental lines and one check/ control.
2) Observation based on randomly selected plants in a row.
3) Compilation of data.
4) Biochemical analysis for protein.

Third Year :

1) Stastical analysis of compiled data.
2) Thesis writing and preparation of research papers.

7) References:

Ahuja, S. L. 1980. Diallel analysis in F_2 generation of mungbean, Thesis Abstact (NAU-Hissar)., 6(2): 110-111.

*Allard, R. W. 1960. Principles of plant Breeding. John Wiley and Sons. Inc. New York.

Anbu Selvam, Y. 2012. Diallel analysis in greengram (*Vigna radiata* (L.) Wilczek) *International Journal of Recent Scientific Research.,* 3(5): 297–299.

Bhatnagar, P. S. and Singh, B. 1966. Heterosis in mungbean. *Indian j. Genet*., 24: 89-99.

Casey, R. and Wringley, C. W. 1982. The importance of seed protein in human nutrition. *Qualitas P1. Fds. For Human Nutrition.,* 31: 189-190.

Choudhary, R. K. 1986. Combining ability for seed yield and its component in mungbean. *Crop. Improv.,* 13(1):95-97.

*Darwin, C. 1876. Cross and self fertilization in vegetable kingdom.

Deshmukh, R. B., Manjare, M. R. 1980. Combining ability in mungbean. *Legume Res*., 3(2): 97-101.

Griffing. B. 1956. Concept of general and specific combining ability in relation to diallel crossing systems. *Aust. J. Biol. Sci.,*463-493.

Halakude, I. S. 1992. Heterosis and combining ability studies in greengram. M. Sc. (Agri.). Thesis, Mahatma Phule Krishi Vidyapeeth, Rahuri.

Hays, H. R., Immer, F. R. and Smith, D. C. 1955. Methods of plant breeding. New York, McGraw Hill book, Co. Inc. 2nd Edn. II- 55/pp.

Isha Parveen, S., Reddi Sekhar, M., Reddy, D. M. and Sudhakar, P. 2013. Heterosis in blackgram (*Vigna mungo* L. Hepper). *J. Agri. and Allied Sci.*, 2(4): 21-25.

Jahagirdar, J. E. 2001. Heterosis and combining ability studies for seed yield and yield components in mungbean. *Indian j. pulses Res.,* 14(2): 141-142.

Kelkar, M. A. 1993. Genetic analysis in mungbean. M. Sc. (Agri.). Thesis, Mahatma Phule Krishi Vidyapeeth, Rahuri.

Kempthorne, O. 1957. An introduction to genetical statistics. John Wiley and Sons, New York.

Koelreuter, J. G. 1866. Vorlaufigen Nachricht Von Einigen das pflauson be Freffonden Versvechen and Boebachtungen. pp. 266 (cited by Shull, G. H. in heterosis Iowa State College Press, pp. 14.).

Lakshmi, V., Narayan Reddy., Reddise Khar, K., Raja Reddy and Hariprasad Reddy, K. 2003. Heterosis in yield and yield components. *Legume Res* ., 26(4): 248-253

Lal, S., Gupta, S. N. and Tomer, Y. S. 1982. L × T analysis in mungbean. *Hariyana Agric. Univ. J. Res.,* 12(3): 438-443.

Manivannan, N. 2002. Line × tester analysis in kharif green gram. *Legume Res.,* 25(2): 127-130.

Naidu, N. V. and Satyanarayan, A. and Seenaiah, P. 1992. Combining ability for yield and yield components in mungbean. *Indian J. Pulses Res.,* 5(2): 192-194.

Naidu, N. V. and Satyanarayan, A. 1993. Heterosis and combining ability in mungbean. *Indian. J. Pulses Res*., 6(1): 38-44.

Panse, V. G. 1957. Genetics of quantitative characters in relation to plant breeding. *Indian J. Genet.,* 17(2): 318-328.

Panse, V. G., and Sukhatme, P. V. 1967. Statistical methods for agricultural workers. *Indian Council of Agric . Res ., New Delhi , pp*, 167-174.

Patel, M. B., Patel, B. N., Savalia, J. J., and Tikka, S. B. S. 2009. Heterosis and genetic architecture of yield, yield contributing traits and yellow mosaic virus in mungbean [*Vigna radiata* (L.) Wilczek]. *Legume Res.,* 32(4): 260-264.

Patil, A. B., Desai, N. C., Mule, P.N., and Khandelwal, V. 2011. Combining ability analysis in mungbean. *Legume Res.,* 34(3):190-195.

Rai, B. 1979. Heterosis breeding. Agro- boil. Pub. New Delhi. Edition- 1: 184.

Reddy, P. R. and Sreeramulu, C. 1982. Heterosis and combining ability for yield and its components in greengram. *Genet. Agraria.,* 36(3/4): 297-307.

Rout K., Mishra, T.K., Pradhan, B. and Bastia, D. 2009. Studies on combining ability for yield components in mungbean *J. Food Legumes,* 22(4):248-250.

*Shull, G. F. 1914. Z. Inductive abstam. Verevbungs lehere, 12: 97-149.

Sonawane, V. P. 1995. Heterosis and combining ability studies in green gram. M. Sc. (Agri.). Thesis. Mahatma Phule Krishi Vidyapeeth, Rahuri.

*Sprague, G. F. and Tatum L. A. 1942. General verses specific combining ability in single crosses of corn. *J. Amer. Soc. Agron.,* 34: 923-932.

Srivastava, R. L. and Singh, G., 2013. Heterosis for yield and its contributing characters in mungbean. (*Vigna radiata* (L.) Wilczek) *Indian J.Sci.Res*., 4(1):131-134.

*Stebbins 1959. The role of hybridization in evaluation. Proc. Amer. Phil. Soc. 103: 231-251.

Sujatha, K., Kajjidoni, S.T., Patil, P.V. and Guddadamath Somashekhar. 2011. Heterosis for productivity related traits involving diverse parents for powdery mildew reaction in mungbean. *Journal of Food Legumes*., 24(2): 101-105.

*Turner, J. H. (Jr.) 1953. A study of heterosis in upland cotton I. Yield of hybrid compared with varieties. Agron. J. 45: 484- 486. II. Combining ability and inbreeding depression. Agron. J. 45: 487- 490.

*Vavilov, N. Z. 1926. Studies on the origin of cultivated plants. *Chronica Botanica.,* 13(1/6): 1949-1950.

*Zukoveskij, P. M. 1962. Cultivated plants and their wild relatives. Commonwelth Agric. Bereaw. London.

* Original not seen.

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